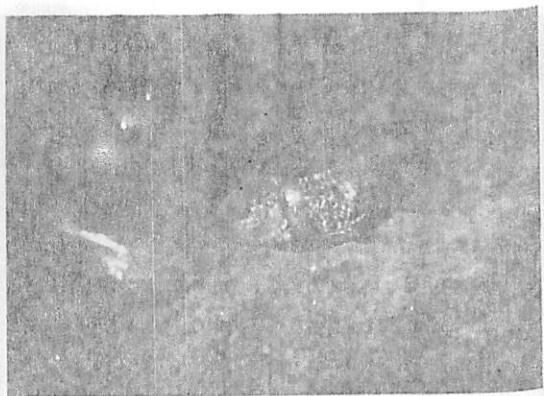


FISH OF TEMPERATE FRESH WATERS

Unlike tropical waters, temperate waters become cold during part of the year. Fish that live in such waters must adjust their living habits to changes in water temperature. For example, in lakes that freeze over during winter, most fish move down to warmer water near the bottom and remain there until spring. The fish pictured here live in temperate lakes, rivers, and streams of North America. Many alewives, coho salmon, rainbow trout, and white sturgeon live in salt water but swim into fresh water to lay their eggs. American eels live in fresh water but swim to the ocean to lay their eggs.



Ron Church, Tom Stack & Associates

Cave Fish live without seeing in the dark waters of caves and underground rivers. These Ozark cave fish have small, sightless eyes, but some other cave fish have no eyes at all.



Redbelly Dace
Pirilla erythrogaster
3 inches (8 centimeters) long



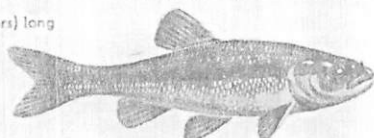
Common Shiner
Notropis cornutus
6 to 8 inches
(15 to 20 centimeters) long



Alewife
Alosa pseudoharengus
3 to 6 inches (8 to 15 centimeters) long



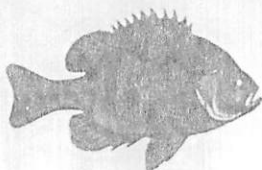
Rainbow Darter
Etheostoma caeruleum
3 inches (8 centimeters) long



Creek Chub
Semotilus atromaculatus
10 to 12 inches (25 to 30 centimeters) long



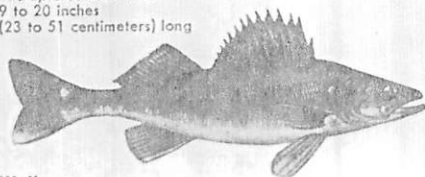
Smallmouth Bass
Micropterus dolomieu
9 to 20 inches
(23 to 51 centimeters) long



Bluegill
Lepomis macrochirus
6 to 9 inches
(15 to 23 centimeters) long



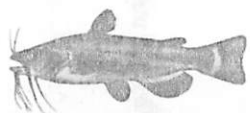
Yellow Perch
Perca flavescens
5 to 12 inches (13 to 30 centimeters) long



Walleye
Stizostedion vitreum vitreum
12 to 27 inches (30 to 69 centimeters) long



Largemouth Bass
Micropterus salmoides
18 inches (46 centimeters) long



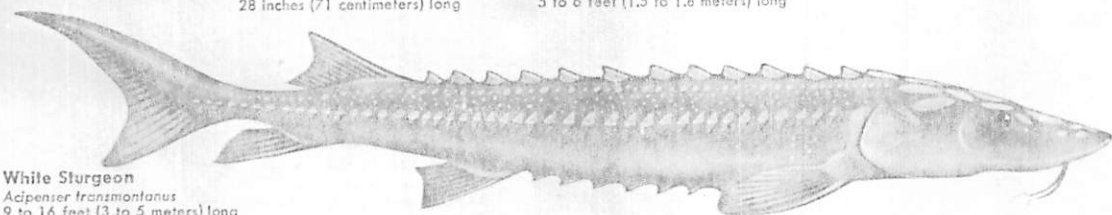
Black Bullhead
Ictalurus melas
1 foot (30 centimeters) long



Channel Catfish
Ictalurus punctatus
28 inches (71 centimeters) long



Longnose Gar
Lepisosteus osseus
5 to 6 feet (1.5 to 1.8 meters) long



White Sturgeon
Acipenser transmontanus
9 to 16 feet (3 to 5 meters) long



Jay Schmidt, FPG



Tom Myers, FPG

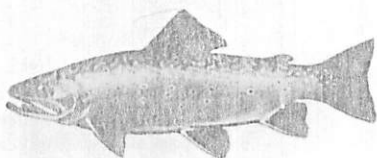
Fighting Foaming Rapids, a rainbow, or steelhead, trout swims from the ocean to fresh water, where it will lay its eggs. This yearly trip makes the rainbow a popular fresh-water game fish.

Kokanee Salmon are a landlocked form of sockeye salmon. They live entirely in fresh water, unlike most other sockeye salmon, which live in the ocean but enter fresh water to lay their eggs.

WORLD BOOK Illustrations by Donald Moss



Pumpkin Seed
Lepomis gibbosus
4 to 8 inches (10 to 20 centimeters) long



Brook Trout
Salvelinus fontinalis
10 inches
(25 centimeters) long



Grass Pickerel
Esox americanus vermiculatus
6 to 10 inches
(15 to 25 centimeters) long



Rainbow Trout
Salmo gairdneri
14 inches
(36 centimeters) long



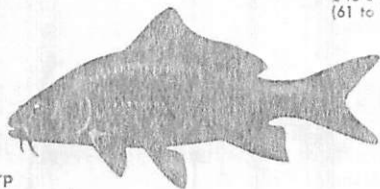
Northern Pike
Esox lucius
28 to 52 inches
(71 to 132 centimeters) long



Coho Salmon
Oncorhynchus kisutch
2 to 3 feet
(61 to 91 centimeters) long



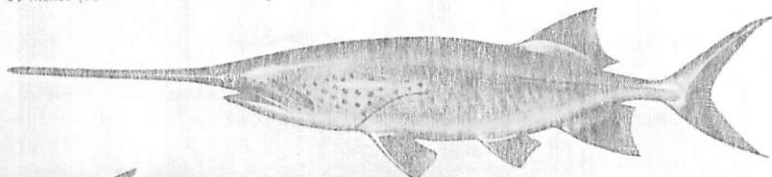
Lake Whitefish
Coregonus clupeaformis
20 to 24 inches (51 to 61 centimeters) long



Carp
Cyprinus carpio
12 to 30 inches (30 to 76 centimeters) long



Muskellunge
Esox masquinongy
40 to 60 inches (100 to 150 centimeters) long



Paddlefish
Polyodon spathula
4 feet (1.2 meters) long



Black Crappie
Pomoxis nigromaculatus
10 to 12 inches
(25 to 30 centimeters) long



Smallmouth Buffalo
Ictalurus bubalus
15 to 26 inches (38 to 66 centimeters) long



American Eel
Anguilla rostrata
3 to 6 feet (0.9 to 1.8 meters) long

FISH / A Classification of Fish

Ichthyologists classify fish into various groups according to the body characteristics they have in common. They divide all fish into two superclasses: (1) *Agnatha*, meaning *jawless*, and (2) *Gnathostomata*, meaning *jawed*. The superclass *Agnatha* consists of a

single class, also called *Agnatha*, which is divided into two orders. The much larger superclass *Gnathostomata* is divided into classes, subclasses, superorders, and orders. The orders are further divided into families, the families into genera, and the genera into species.

SUPERCLASS AGNATHA. Mouth jawless; skeleton of cartilage; no paired fins, air bladder, or scales; about 45 species in 2 orders:

- Order *Petromyzoniformes*—lampreys. Large sucking mouth; 7 pairs of external gill openings; some species parasitic; live in salt and fresh water.
- Order *Myxiniiformes*—hagfish. Small nonsucking mouth; 1 to 16 pairs of external gill openings; nonparasitic; salt water.

SUPERCLASS GNATHOSTOMATA. Mouth jawed; most species have paired fins and scales; about 21,000 species in 2 classes:

Class Chondrichthyes. Skeleton of cartilage; no air bladder; about 600 species in 3 orders:

- Order *Squaliformes*—sharks. Most have torpedo shape; upturned tail; 5 to 7 pairs of gill slits; no gill covers; placoid scales; mostly salt water.
- Order *Rajiformes*—rays. Most have body flattened from top to bottom; whiplike tail; 5 pairs of gill slits under pectorals rather than on sides; no gill covers; placoid scales; mostly salt water.
- Order *Chimaeriformes*—chimaeras. Short-, long-, and elephant-nosed species; pointed tail; 4 pairs of gill slits; gill covers; scaleless; salt water.

Class Osteichthyes. Skeleton largely or partly bone; most species have 5 pairs of gill slits, gill covers, air bladder, and cycloid or ctenoid scales; over 20,000 species in 2 subclasses:

Subclass Sarcopterygii. Lobed fins; skeleton partly cartilage and partly bone (primitive bony); 7 species in 2 orders:

- Order *Dipteriformes*—lungfish. Air bladder an air-breathing lung; fresh water.
- Order *Coelacanthiformes*—coelacanth. Single ancient species; salt water.

Subclass Actinopterygii. Rayed fins; skeleton largely or partly bone; single dorsal and anal fins in most orders; divided into 3 superorders:

Superorder Chondrostei. Skeleton largely cartilage with little bone (primitive bony); sharklike tail; about 40 species in 2 orders:

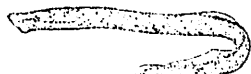
- Order *Polypteriformes*—bichirs. Slender body; thick ganoid scales; long dorsal fin composed of separate finlets; lunglike air bladder; fresh water.
- Order *Acipenseriformes*—paddlefish, sturgeon. Heavy body; paddlefish nearly scaleless; sturgeon have bony plates instead of scales; fresh water; some sturgeon anadromous.

Superorder Holostei. Skeleton mostly bone with little cartilage (primitive bony); nearly symmetrical tail; fresh water; 8 species in 2 orders:

- Order *Semionotiformes*—gars. Long, slender body and jaws; short, far-back dorsal fin; diamond-shaped ganoid scales; lunglike air bladder.
- Order *Amlifformes*—bowfin. Stout body, rounded tail fin; long, wavy dorsal fin; cycloid scales; bony plate under chin; single species.

Superorder Teleostei. Skeleton largely bone (modern bony); soft or spiny fin rays; symmetrical tail fin; about 20,000 species in 30 orders:

- Order *Elopiiformes*—bonefish, tarpon, ten-pounders. Soft fin rays; low pectorals; abdominal pelvis; deeply forked tail; silvery body; mostly salt water.
- Order *Anguilliformes*—eels. Soft fin rays; many species lack pectorals; no pelvis; some species scaleless; snake-like; mostly salt water; some catadromous.
- Order *Notacanthiformes*—spiny eels. Soft and spiny fin rays; low pectorals; abdominal pelvis; no tail fin; long, tapering body; salt water, on bottom.
- Order *Clupeiformes*—anchovies, herring, sardines, shad. Soft fin rays; low pectorals; abdominal pelvis; deeply forked tail; silvery body flattened from side to side; travel in large schools; mostly salt water.
- Order *Mormyriiformes*—Mormyrids. Soft fin rays; low pectorals; abdominal pelvis; many have long snout; electricity-producing organs; fresh water.
- Order *Osteoglossiformes*—bony tongues, fresh-water butterfly fish, mooneyes. Soft fin rays; low pectorals; abdominal pelvis; many have large scales and rounded tail fins; extremely varied body forms; fresh water.
- Order *Salmoniformes*—dragonfish, mudminnows, pike, salmon, viperfish. Soft fin rays; salmon have a second, adipose (fatty and rayless) dorsal fin; most have low pectorals; abdominal pelvis; salt and fresh water.
- Order *Myctophiformes*—lantern fish, lizard fish. Soft fin rays; many species have a second, adipose dorsal; fairly low pectorals; abdominal pelvis; many have light-producing organs; mostly deep salt water.
- Order *Cypriniformes*—characins, gymnotid eels, loaches, minnows, suckers. Soft fin rays; most characins have a second, adipose dorsal; most species have low pectorals, abdominal pelvis; air bladder connected to inner ear by series of bones called *Weberian apparatus*; extremely varied body forms; fresh water.



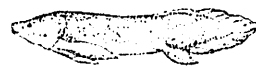
Lamprey
(*Petromyzoniformes*)



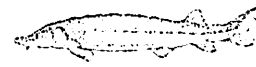
Blue Shark
(*Squaliformes*)



Little Skate
(*Rajiformes*)



Australian Lungfish
(*Dipteriformes*)



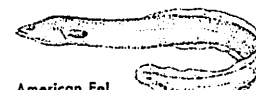
Sturgeon
(*Acipenseriformes*)



Longnose Gar
(*Semionotiformes*)



Bonefish
(*Elopiiformes*)



American Eel
(*Anguilliformes*)



American Shad
(*Clupeiformes*)



Mormyrid
(*Mormyriiformes*)

This table lists the major groups down through orders into which fish are classified. The groups are arranged according to their probable evolutionary development. One or more representative families are listed after the name of each order, along with important characteristics

of the fish in the order. The table lists 41 orders. But some ichthyologists list fewer than 41, and others list more. Ichthyologists also disagree on the names of some orders, the way the orders should be arranged, and the species included in each.

SUPERCLASS GNATHOSTOMATA (continued)

- Order Siluriformes**—catfish. Soft fin rays, but some species have dorsal and pectoral spines; some have a second, adipose dorsal; low pectorals; abdominal pelvis; most scaleless; all have Weberian apparatus and barbels; mostly fresh water.
- Order Goniorhynchiformes**—sandfish. Soft fin rays; low pectorals; pelvis behind abdomen; slender body; beaked snout; primitive Weberian apparatus; salt water.
- Order Percopsiformes**—cave fish, pirate perch, trout perch. Soft fin rays except for a few spiny rays in pirate perch and trout perch; trout perch have a second, adipose dorsal; low pectorals; pelvis far forward but lacking in most cave fish; large lateral line canals in head; fresh water.
- Order Batrachoidiformes**—toadfish. Spiny and soft fin rays; two dorsal fins—one spiny, one soft; pectorals midway up sides; pelvis under throat; some have light-producing organs; many have poisonous spines; mostly salt water.
- Order Gobiesociformes**—clingfish. Soft fin rays except for single spines in pelvis; pectorals midway up sides; pelvis, under throat, form sucking disk that enables fish to cling to rocks; scaleless; small body; mostly salt water.
- Order Lophiiformes**—anglers, batfish, frogfish, goosefish. Spiny and soft fin rays; dorsal fin has spiny ray at front, forming dangling lure; pectorals midway up sides, forming fleshy flaps; pelvis under throat or lacking; broad, flat body; many species have light-producing organs; salt water.
- Order Gadiformes**—cod, eelpouts, pearlfish. Most have soft fin rays; some cod have three dorsals, two anals; high pectorals; pelvis far forward; mostly salt water.
- Order Atheriniformes**—flying fish, halfbeaks, killifish, needlefish, live-bearing topminnows. Most have soft fin rays; pectorals high or midway up sides; abdominal pelvis; near surface of salt, fresh, and brackish water.
- Order Polymixiformes**—beardfish. Spiny and soft fin rays; pectorals midway up sides; pelvis under chest; forked tail; two chin whiskers; salt water.
- Order Beryciformes**—pinecone fish, squirrelfish. Spiny and soft fin rays; pectorals midway up sides; pelvis under chest; brilliantly colored; salt water.
- Order Zeiformes**—boarfish, dories. Spiny and soft fin rays; pectorals midway up sides; pelvis under chest; body extremely flattened from side to side; up-turned mouth; salt water.
- Order Lampridiformes**—crestfish, oarfish, opahs, ribbonfish. Soft fin rays; many species have unusually long dorsal and anal fins; pectorals midway up sides; pelvis under chest or lacking; varied body forms; salt water.
- Order Gasterosteiformes**—pipefish, sea horses, sticklebacks, trumpetfish. Spiny and soft fin rays; pectorals midway up sides; pelvis under chest; slender body; tubular snout; many encased in bony plates or rings; salt and fresh water.
- Order Channiformes**—snakeheads. Soft fin rays; low pectorals; pelvis under chest or lacking; special air-breathing organs; fresh water.
- Order Scorpaeniformes**—scorpionfish, sculpins. Spiny and soft fin rays; usually two dorsals—one spiny, one soft; pectorals midway up sides; pelvis under chest; cheek covered by bony plate; many have extremely sharp, poisonous spines; varied body forms; salt and fresh water.
- Order Pegasiformes**—sea moths. Spiny and soft fin rays; large, spiny, winglike pectorals high on sides; small pelvis between chest and abdomen; small body encased in bony plates and rings; extended snout; salt water.
- Order Dactylopteriformes**—flying gurnards. Spiny and soft fin rays; two dorsal fins—one spiny, one soft; huge, winglike pectorals midway up sides; pelvis under chest; head encased in heavy bone; salt water.
- Order Synbranchiformes**—swamp eels. Soft fin rays; dorsal and anal fins rayless; no pectorals; pelvis under throat or lacking; gill openings under head; special air-breathing organs; eel-shaped body; fresh and brackish water.
- Order Perciformes**—bass, blennies, gobies, jacks, mackerel, perch. Spiny and soft fin rays; many have two dorsal fins—one spiny, one soft; pectorals midway up sides; pelvis under chest and composed of one spine and five soft rays in most species; extremely varied body forms; largest fish order, with 8,000 to 10,000 species; salt and fresh water.
- Order Plouronectiformes**—flounders, soles, tonguefish. Most have soft fin rays; long dorsal and anal fins; pectorals and pelvis small or lacking; flattened body; adults have both eyes on same side of head; mostly salt water.
- Order Tetraodontiformes**—boxfish, ocean sunfish, puffers, triggerfish. Spiny and soft fin rays; pectorals midway up sides; pelvis under chest or lacking; scaleless or covered with spines, bony plates, or hard scales; many are poisonous to eat; varied body forms; mostly salt water.



Blue Catfish
(Siluriformes)



Trout Perch
(Percopsiformes)



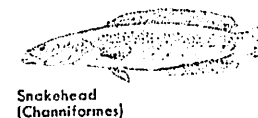
Goosefish
(Lophiiformes)



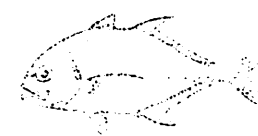
Flying Fish
(Atheriniformes)



Oarfish
(Lampridiformes)



Snakehead
(Channiformes)



Common Jack
(Perciformes)



Naked Sole
(Pleuronectiformes)

Related Articles in WORLD BOOK include:

FRESH-WATER FISH

Alewife	Eel	Pickering
Anableps	Electric Eel	Pike
Archerfish	Electric Fish	Piranha
Bass	Fighting Fish	Pupfish
Blindfish	Flame Tetra	Roach
Bowfin	Gar	Salmon
Buffalo Fish	Goldfish	Sculpin
Bullhead	Grayling	Smelt
Carp	Lamprey	Stickleback
Catfish	Lungfish	Sturgeon
Chub	Minnow	Sucker
Crappie	Muskellunge	Sunfish
Darter	Paddlefish	Trout
Drum	Perch	Whitefish

SALT-WATER FISH

Alewife	Haddock	Sardine
Amber Jack	Hagfish	Sawfish
Anchovy	Hake	Sculpin
Angelfish	Halibut	Scup
Barracuda	Herring	Sea Bat
Bass	Jewfish	Sea Horse
Blackfish	John Dory	Shad
Bluefish	Kingfish	Shark
Bonefish	Lamprey	Skate
Bonito	Lantern Fish	Smelt
Butterfish	Lumpfish	Snapper
Candlefish	Mackerel	Sole
Catfish	Marlin	Spot
Cod	Menhaden	Sprat
Coelacanth	Mullet	Stickleback
Cutlass Fish	Oarfish	Sting Ray
Doctorfish	Pilot Fish	Sturgeon
Dogfish	Pipefish	Swordfish
Dolphin	Pollack	Tarpon
Drum	Pompano	Tilefish
Eel	Porcupine Fish	Toadfish
Electric Fish	Porgy	Torpedo
Flatfish	Puffer	Trout
Flounder	Ray	Tuna
Flying Fish	Redfish	Turbot
Grouper	Remora	Wahoo
Grunion	Rosefish	Weakfish
Grunt	Sailfish	Wolf Fish
Gurnard	Salmon	

OTHER RELATED ARTICLES

Animal (pictures)	Ichthyology
Aquaculture	Instinct
Aquarium	Ocean (pictures: Life in the Ocean)
Conservation (picture: "Planting" Fish)	Plankton
Evolution (chart)	Prehistoric Animal
Fish and Wildlife Service	Reproduction (Sexual Reproduction in Animals)
Fishery	Sea Serpent
Fishing	Spawn
Fishing Industry	Tropical Fish
Fossil (picture: Fish Skeleton)	

Outline

- I. The Importance of Fish
 - A. Food and Game Fish
 - B. Other Useful Fish
 - C. Harmful Fish
 - D. Fish in the Balance of Nature
- II. Kinds of Fish
 - A. Bony Fish
 - B. Sharks, Rays, and Chimaeras
 - C. Lampreys and Hagfish

III. Where Fish Live

- A. Salt-Water Environments
- B. Fresh-Water Environments
- C. Fish Migrations

IV. The Bodies of Fish

- A. External Anatomy
- B. Skeleton and Muscles
- C. Systems of the Body
- D. Special Organs

V. The Senses of Fish

- A. Sight
- B. Hearing
- C. Smell and Taste
- D. Touch and the Lateral Line System
- E. Other Senses

VI. How Fish Live

- A. How Fish Get Food
- B. How Fish Swim
- C. How Fish Protect Themselves
- D. How Fish Rest
- E. How Fish Live Together
- F. How Fish Adjust to Change

VII. How Fish Reproduce

- A. Preparation for Spawning
- B. Spawning and Care of the Eggs
- C. Hatching and Care of the Young

VIII. The Development of Fish

- A. The First Fish
- B. The Age of Fish
- C. The First Modern Fish

IX. A Classification of Fish

Questions

- What kind of food do most fish eat?
 How are lampreys and hagfish different from other fish?
 What are median fins? Paired fins? Chromatophores?
 How great a change in water temperature can most fish survive?
 What are fish farms?
 What is the name of the process by which most fish eggs are fertilized?
 Which parts of the world have the most species of fresh-water fish?
 What were ostracoderms?
 How do fish turn and make other swimming maneuvers?
 What are the two main groups of jawed fish? How do they differ?

Books for Young Readers

- FEGLY, THOMAS D. *The World of Freshwater Fish*. Dodd, 1978.
 FLETCHER, ALAN M. *Fishes Dangerous to Man*. Addison-Wesley, 1969. *Fishes That Travel*. 1971. *Fishes That Hide*. 1973. *Fishes and Their Young*. 1974.
 OMMANNEY, FRANCIS D. *The Fishes*. Time Inc., 1970.
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Books for Older Readers

- ADLER, HELMUT E. *Fish Behavior: Why Fishes Do What They Do*. T.F.H. Publications, 1975.
 BUDKER, PAUL. *The Life of Sharks*. Rev. ed. Columbia, 1971.
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 LAGLER, KARL F., and others. *Ichthyology*. Wiley, 1962.
 MIGDALSKI, EDWARD C., and FIGHTER, G. S. *The Fresh and Salt Water Fishes of the World*. Knopf, 1976.
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